AFRL-RH-WP-TR-2009-0030

Tailored Common Operating Picture (COP)

Andrea L. Cooks
Kelly Cox
Steve Hattabaugh
SRA International, Inc.
SRA C41SR Center
5000 Springfield Street, Suite 200
Dayton OH 45431

March 2009

Final Report for the period March 2007 to September 2008

DESTRUCTION NOTICE – Destroy by any method that will prevent disclosure of contents or reconstruction of this document.

Air Force Research Laboratory
Human Effectiveness Directorate
711th Human Performance Wing
Warfighter Interface Division
Battlespace Visualization Branch
Wright-Patterson AFB OH 45433

NOTICE AND SIGNATURE PAGE

Using Government drawings, specifications, or other data included in this document for any purpose other than Government procurement does not in any way obligate the U.S. Government. The fact that the Government formulated or supplied the drawings, specifications, or other data does not license the holder or any other person or corporation; or convey any rights or permission to manufacture, use, or sell any patented invention that may relate to them.

This report was cleared for public release by the 88th Air Base Wing Public Affairs Office and is available to the general public, including foreign nationals. Copies may be obtained from the Defense Technical Information Center (DTIC) (http://www.dtic.mil).

AFRL-RH-WP-TR-2009-0030 HAS BEEN REVIEWD AND IS APPROVED FOR PUBLICATION IN ACCORDANCE WITH ASSIGNED DISTRIBUTION STATEMENT.

FOR THE DIRECTOR

//signed//
Denise L. Aleva
Senior Engineering Research Psychologist
Battlespace Visualization Branch

//signed//
Daniel G. Goddard
Chief, Warfighter Interface Division
Human Effectiveness Directorate
711th Human Performance Wing
Air Force Research Laboratory

This report is published in the interest of scientific and technical information exchange, and its publication does not constitute the Government's approval or disapproval of its ideas or findings.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
16-03-2009	Final	March 2007 to September 2008

4. TITLE AND SUBTITLE
Tailored Common Operating Picture (COP)

5a. CONTRACT NUMBER
FA8650-04-D-6405

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER
63231F

6. AUTHOR(S)
Andrea L. Cooks
Kelly Cox
Steve Hattabaugh

5d. PROJECT NUMBER
2830

5e. TASK NUMBER
30

5f. WORK UNIT NUMBER
28303021

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
SRA International, Inc.
SRA C4ISR Center
5000 Springfield Street, Suite 200
Dayton Ohio 45431

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Force Materiel Command
Air Force Research Laboratory
711th Human Performance Wing
Human Effectiveness Directorate
Warfighter Interface Division
Battlespace Visualization Branch
Wrigh-Patterson AFB OH 45433

10. SPONSOR/MONITOR'S ACRONYM(S)
711 HPW/RHCV

11. SPONSORING/MONITORING AGENCY REPORT NUMBER
AFRL-RH-WP-TR-2009-0030

12. DISTRIBUTION AVAILABILITY STATEMENT
Approved for Public release; distribution unlimited.

13. SUPPLEMENTARY NOTES
88 ABW/PA cleared 3/24/2009; 88ABW-09-1158.

14. ABSTRACT
This research and development effort explored the concept of today's implementation of a Common Operating Picture (COP) and its ability to support warfighters as they complete tasks, make decisions, and collaborate with a multitude of team members. The information learned and concepts developed during this effort can be leveraged for any domain as an initial step for creating a tailored COP.

15. SUBJECT TERMS
Common Operating Picture (COP)

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Denise L. Aleva
Unclassified	Unclassified	Unclassified	SAR	26	19b. TELEPONE NUMBER (*Include area code)*

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39

THIS PAGE LEFT INTENTIONALLY BLANK

Table of Contents

Section Page

1.0 Summary 1
2.0 Introduction 3
3.0 Methods, Assumptions and Procedures 6
3.1 Data Collection 6
3.2 Data Collection Sites 6
3.3 User Group 7
4.0 Results and Discussion 8
4.1 Previous COP Assessment Results 8
4.2 Understanding Situation Awareness and the COP 9
4.3 Data Collection Results 10
4.3.1 CAOC-N, Nellis AFB 10
4.3.2 JEFX 08-1, Barksdale AFB 11
4.3.3 Additional Data Collection 11
4.4 Elements of a tailored COP 11
5.0 Conclusion 12
6.0 Recommendations 13
6.1 Conceptual Scenario 14
7.0 References 19
Abbreviations & Acronyms 20

List of Figures

Figure Page

Figure 1: EMMA© COP 3
Figure 2: WebEOC COP 4
Figure 3: C2PC COP 4
Figure 4: Typical arrangement of the Data Wall on the Combat Ops Floor for JEFX 06 8
Figure 5: Main screen with Layers and Map Tools 13
Figure 6: Operations Center COP 15
Figure 7: Convoy COP 15
Figure 8: Director/Main COP 15
Figure 9: History Function 15
Figure 10: Notes 16
Figure 11: Sharing Display Functionality 16
Figure 12: Merged Screens 17
Figure 13: Schedule Panel 17
Figure 14: Layers Panel 18

Preface

This effort was conducted by the Battlespace Visualization Branch, Warfighter Interface Division, Human Effectiveness Directorate, 711th Human Performance Wing of the Air Force Research Laboratory (711 HPW/RHCV), Wright-Patterson Air Force Base, Ohio, under Work Unit 2830HXC3. It was supported by SRA International, Inc., Dayton, Ohio, under Contract FA8650-04-D-6405, Task Order 003. Mr. Gilbert Kuperman was the task order manager and Ms. Denise Aleva was the project manager for the Air Force for this effort. Captain Doug Simmers (711 HPW/RHX) served as the contract manager.

This research and development effort explored the concept of a tailored implementation of a Common Operating Picture (COP) and its ability to support warfighters as they complete tasks, make decisions, and collaborate with a multitude of team members. This report documents the findings of this effort.

THIS PAGE LEFT INTENTIONALLY BLANK

1.0 Summary

The concept of a Common Operating Picture (COP) is flawed by definition. Based on today's implementations, there is no common picture that benefits all warfighters on the floor of the Air and Space Operations Center (AOC). Yet, data walls continue to be developed that include a COP with the purpose of providing a display for all to see and use. Typically, a large database of information is accessed and relevant (or irrelevant) data items are displayed to the entire AOC. The goal is often a generic operating picture, similar to a top level composite view of the Air Tasking Order, which is not particularly helpful to individual operators. This display is typically ignored by those who are responsible for specific aspects of mission execution as it does not provide the specific information they need or it is too cluttered to be useful. The display may provide a high-level view of the situation for leadership. However, it is often regarded simply as "eye candy for visitors." Too often, emerging technology drives the display with the motto "if it can be displayed, it is." This approach of supplying everything results in information overload for operators who are making critical decisions under extreme time pressure. They simply cannot sort through the barrage of information to find what they need, assuming the information is available on the COP. What is needed is a tailored COP that supports these operators as they complete tasks, make decisions, and collaborate with a multitude of team members.

We began this research to both gain a better understanding of what information individual operators in the AOC needed to successfully complete their tasking and learn how that information should be displayed on a tailored COP. The original intention was to design tailored COPs for Combat Operations Division (COD) cells for evaluation at Joint Expeditionary Force Experiment (JEFX) 08 exercises. However, as JEFX-08 was restructured with limited focus on the COD, we modified our research to understanding the visualization and functionality requirements that are critical to establishing a successful tailored COP in any domain. During our research we discovered that some primary issues included the following:

- Legibility problems of the displays
- Poor usability
- Lack of critical information
- Data overload and clutter

The data collection and document review strengthened the idea that there are key elements that need to be implemented in a tailored COP to maximize the operator's efficiency and productivity. The results of our study concluded that a tailored COP would allow operators to identify the specific information they want to monitor, eliminating excess unused data from interfering with the desired data. This implementation would provide multiple data layers to allow operators to easily select the information they wish to view and deselect information they do not need and would allow the operator to easily switch between critical displays. The information learned and concepts developed during this effort can be leveraged for any domain as an initial step for creating a tailored COP. With current interest in integrating the air and ground picture, as well as adding applicable space and cyber information to the COP, tailoring has become increasingly important.

THIS PAGE LEFT INTENTIONALLY BLANK

2.0 Introduction

Possessing an accurate and complete picture of the battlefield has always been a requirement for analysts and military commanders. For years, we have used a variety of graphical representations to obtain this picture, evolving from simple illustrations to complex informational displays. The intent of these visualizations is to provide analysts with the ability to effectively identify, process, and comprehend the critical data elements of the mission. These display visualizations are commonly referred to as the Common Operating Picture (COP) of the mission and can be found in many commercial and military operations. Unfortunately, the concept of a COP is flawed by definition. In many environments, including the military, it is difficult to create a common picture that benefits everyone. This is particularly true in large operation centers where there are a wide variety of analysts who require different information to complete their tasks. Yet, large data walls, including a COP, continue to be developed with the sole purpose of providing a display for all to see and use. Figures 1 – 3 show some example COP displays).

Figure 1: EMMA© COP
EMMA©, the Emergency Management Mapping Application developed by Towson University. EMMA© is a secure, content- and tool-rich Web-based mapping application that enables first responders and emergency managers to share a common operating picture by locating incidents on a map, describing affected areas, and viewing relevant real-time information. (www.marylandgis.net/hls.jsp)

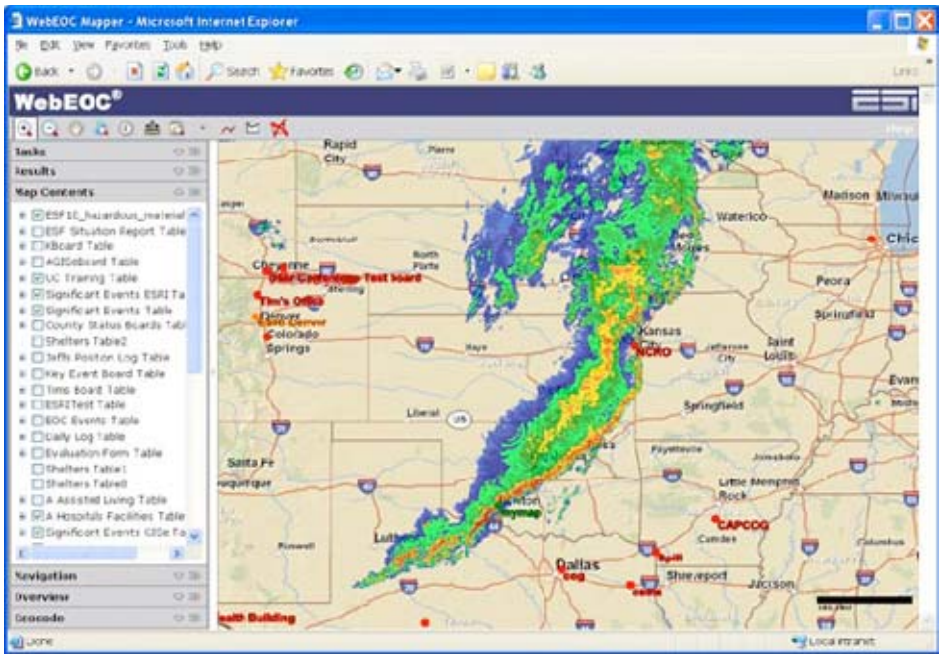

Figure 2: WebEOC COP
WebEOC is the original web-enabled crisis information management system developed by ESi. (http://www.esi911.com/home/)

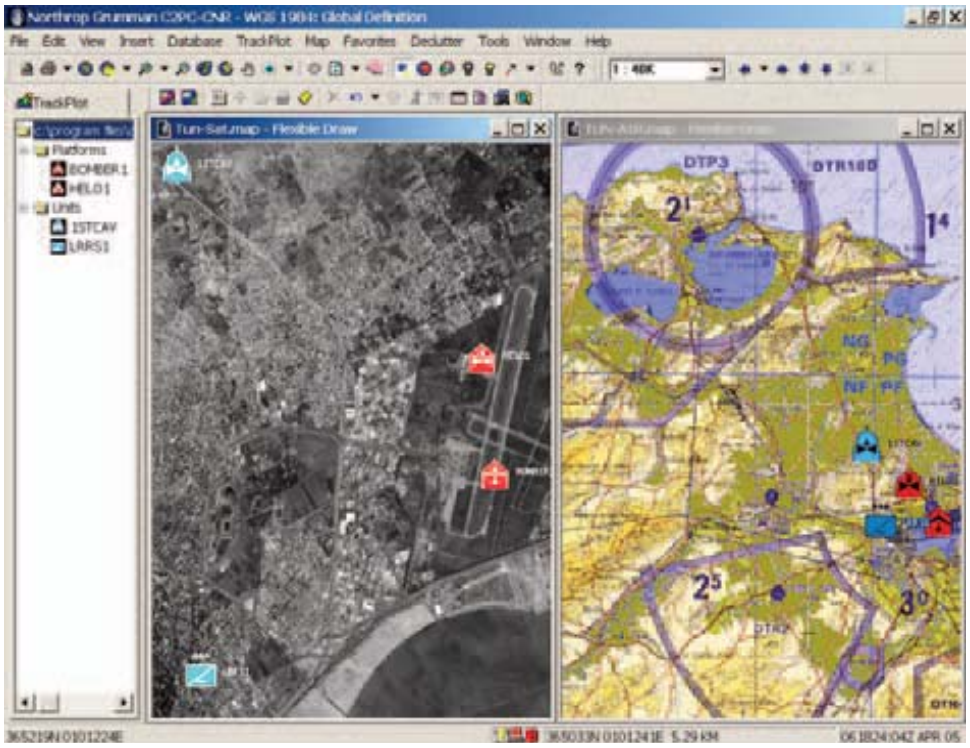

Figure 3: C2PC COP
Command and Control for the Personal Computer (C2PC) facilitates the creation and visualization of the Common Tactical Picture (CTP) or Common Operational Picture (COP) in a Microsoft Windows environment, developed by Northrop Grumman. (http://www.ngms.eu.com/Products/c2pc.htm)

Typically in an Air and Space Operations Center (AOC), a large database of information is accessed and data items are displayed to the entire AOC. The result is often a generic operating picture, similar to a top level composite view of the Air Tasking Order. These generic COPs usually do not provide much benefit to the primary operators and are typically ignored by those who are responsible for mission execution.

Too often, emerging technology drives the display instead of the needs of the user. That is, if it can be displayed, it is. This approach of supplying everything results in operators being flooded with unnecessary information. Analysts simply cannot sort through the barrage of information to find what they need. We believe what is needed is a tailored COP that supports these multi-tasked analysts as they complete tasks, make decisions, and collaborate with a multitude of team members. To begin to understand this issue, the Air Force Research Laboratory (AFRL) Human Effectiveness Directorate (RH) tasked SRA International, Inc. to explore the information requirements of these warfighters and to develop a conceptual prototype that demonstrates the basic functionality that is needed for a tailored COP.

This report is structured as follows. Section 3 contains an explanation of the methods, assumptions, and procedures used to collect data and to study this issue. Section 4 discusses the results of the data collection and research. In section 5 we discuss conclusions that can be drawn from the research. We conclude with design recommendations in section 6.

3.0 Methods, Assumptions and Procedures

We began this research with the goal of gaining a clear understanding of what information individual operators in the AOC needed to successfully complete their tasking and to discover how that information should be displayed on a tailored COP. We specifically wanted to focus our efforts on the Combat Operations Division (COD), within the AOC, to determine both which teams within the division would most benefit from tailored COPs and how these tailored COPs might facilitate coordination and synchronization between cells and teams in support of multiple efforts. Our objective was to identify the decisions, judgments, cues, tasks, situation awareness (SA) elements, and collaboration requirements that were critical to mission success. This would allow us to determine what information would be most useful on shared displays and whether some shared displays should be focused or tailored for specific cells or teams. Our original intention was to design tailored COPs for Combat Operations Division (COD) cells for evaluation at Joint Expeditionary Force Experiment (JEFX) 08 exercises. However, as JEFX-08 was restructured with limited focus on the COD, we modified our research to understanding the visualization and functionality requirements that are critical to establishing a successful tailored COP in any domain. The following sections discuss issues regarding the collection of data, the sites, and a specific user group.

3.1 Data Collection

For this effort the initial method used for obtaining information included conducting both informal observations and informal interviews with operators. However, most often, the team had to rely on documentation and internal subject matter experts (SMEs) to gain a better understanding of what functionality is required to create a successful tailored COP.

The data collection plan for the first opportunity focused on achieving an understanding of the AOC as a whole, as well as methods for understanding individual users and how they used the current COP. Through the remaining data collection opportunities, our team gathered direct feedback on advantages and disadvantages of using a COP display and explored the following research questions:

- What data would be most useful?
- What displays should be tailored for specific groups or teams?
- Should shared displays be interactive for collaboration?

3.2 Data Collection Sites

For this task, we visited the Combined Air and Space Operations Center at Nellis AFB (CAOC-N) and we participated in the Joint Expeditionary Force Experiment (JEFX) 08-1 at Barksdale AFB. At Nellis, we observed operators participating in the United States Air Force Weapons School (USAFWS) exercise. During this event we were also given the opportunity to have a roundtable discussion with representatives from Intel, Space, and Special Tactics (STS). The operators provided us with feedback of their impressions – of the current COP, the applications they use, and recommendations for improvements.

During the JEFX 08-1 event, the team observed operators at Barksdale AFB in Shreveport, Louisiana. As with any exercise, there were limited opportunities to interview users directly since they were focused on their tasks. However, we still had various opportunities to observe operators performing tasks; although, no additional feedback was obtained regarding what information could be useful on a tailored COP.

In addition to observing operators at Barksdale AFB and Nellis AFB, we had the opportunity to interview a past JEFX 06 participant, who served as the Chief of Combat Operations during the exercise. The interviewee had a range of knowledge and ideas regarding the tailored COP and how a tailored COP should be implemented.

3.3 User Group

During the data collection process, it was challenging to focus on a specific user group within the AOC community due to the limited data collection opportunities. The initial data collection trips to Nellis and Barksdale provided the team with some insight into the potential user set. However, it was determined that more data would need to be collected to identify a critical user group. So the team focused on designing a tailored COP for any operator working in an operation center environment.

4.0 Results and Discussion

4.1 Previous COP Assessment Results

To begin the research, we used as a baseline the results from a Human System Integration (HSI) assessment performed during the Joint Expeditionary Force Experiment 2006 (JEFX 06). The assessment team focused mainly on the data wall within combat operations. The data wall displays consisted of a series of projected displays that portrayed various geo-spatial representations of the battlespace. Typically, there are three separate, but related, geo-spatial views displayed on the data wall: (1) Air Defense System Integrator (ADSI) display, (2) a combined Web Enabled Execution Management Capability (WEEMC) and Command and Control Personal Computer (C2PC) display, and (3) COP from the Integrated C4I System Framework (ICSF). For JEFX 06, the ADSI, WEEMC, and COP were each displayed on two data wall displays in the Combat Operations Division, See Figure 4 for typical data wall arrangements. The assessment identified various HSI issues involving COP displays in the AOC environment. The assessors concluded that the situational displays (WEEMC, C2PC, and ISCF) currently used by operators in the field did not provide all the functionality to effectively support the level of SA required for agile continuous planning and execution. The HSI team reported the following issues regarding the displays during their assessment: (1) limited display space for the number of windows required for data manipulation, situation assessment, and communications; (2) inconsistencies within and across applications; and (3) insufficient concepts of operations (CONOPS) and training needed to adjust the tools to the needs of specific operators.

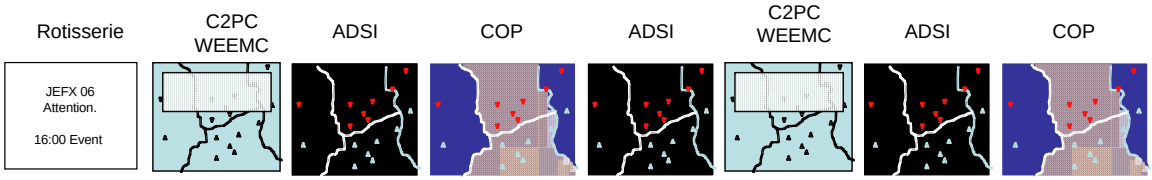

Figure 4: Typical arrangement of the Data Wall on the Combat Ops Floor for JEFX 06

Overall, the major concern for SA for the operations floor was the lack of well designed COP displays. The displays on the data wall and the individual workstations were not able to present a clear picture of the air and space operations. They reported that this was dangerous – operators were devoting too much time and energy struggling with the interfaces instead of devoting their time to managing the war. As a result, the following recommendations were provided to improve the display:

- Improve legibility problems
- Improve color reproduction problems
- Reduce/redesign menus and control icons that obstruct the view of critical information
- Reduce COP clutter
- Increase the display of useful information
- Provide templates for easy tailoring to crew positions

4.2 Understanding Situation Awareness and the COP

To provide a tailored COP for a variety of operators, you must first understand the concept of SA. SA has been defined in a variety of ways, but the basic idea is that people can achieve SA if they can identify, process, and comprehend critical pieces of information regarding what is happening (Livnat, Agutter, Moon & Foresti 2005). Obtaining SA is important in many domains, including the military, commercial aviation, cargo transportation, power distribution, emergency management, business intelligence, forensics, and artificial intelligence domains. In the past, these fields have used visualizations to improve SA for operators by enhancing human perception and cognitive ability. The right visualizations can increase a person's ability to rapidly correlate data and recognize links. With these things in mind, a display must take into account the decision making process: identifying problems, characterizing them, and determining appropriate responses. The process is only practical if the information to be managed is in a format that can be used. It must be presented in such a manner that the user will not be required to make too many inferences, mental manipulations or search for needed information among irrelevant data. The final product must be flexible and give the user the ability to define the parameters to be displayed, but must also have a large number of intuitive characteristics. In our research we found many studies investigating SA formation. In particular, Dr. Mica Endsley provides that there are three basic levels of SA: perception, comprehension, and projection.

1. Perception is the first step in achieving SA, meaning to perceive the status, attributes, and dynamics of relevant elements in the environment. Thus, perception involves the processes of monitoring, cue detection, and simple recognition, which leads to an awareness of multiple situational elements (objects, events, people, systems, environmental factors) and their current states (locations, conditions, modes, actions).

2. Comprehension is the next step in SA formation, which involves a synthesis of disjointed perception SA elements through the processes of pattern recognition, interpretation, and evaluation. Comprehension requires integrating this information to understand how it will impact upon the individual's goals and objectives. This includes developing a comprehensive picture of the world or of that portion of the world of concern to the individual.

3. Finally, projection, the third and highest level of SA, involves the ability to project the future actions of the elements in the environment. Projection is achieved through acquiring both knowledge of the status (and dynamics) of the elements and comprehension of the situation, and then extrapolating this information and thinking forward through time to determine how it will affect future states of the operational environment.

(Endsley, 1995)

In current designs, the COP tries to provide the operators with an easy to read graphic representation of the data they are reviewing to help them obtain SA. However, there are some significant limitations that prevent the complete processing of SA. The amount of data processed by these systems can be extremely large. This creates a significant lag in the processing time for this data. This can and is being overcome as technology continues to be improved. Additionally, an operator is also susceptible to information overload when trying to evaluate huge amounts of

data being processed. It is important to successfully allocate data between the operator and the machine so that information can be processed in a timely manner. This creates a need for constantly increasing the sensitivity and selectivity of the systems, which automatically process data (Artman, 2000). If there is any alteration, or upgrade to any part of this information (e.g. an upgrade to any adversary's weapon system), the computer may misidentify the object and provide the warfighters with erroneous data. The data being presented to the operator must prove trustworthy at all times.

Furthermore, once the information has been processed, it must be shared in a format usable by all interested parties, including the operator. Once accessed, the operator must be able to quickly and accurately identify the information and act upon it. All involved parties must be able to use the software, and users should be able to add to the software without violating proprietary or security rules or regulations (Artman, 2000).

There are already many software applications in use today that can display a COP. Software applications such as FalconView™, Google™ Earth, and Microsoft® Virtual Earth™ provide a great asset for graphically displaying data. ArcGIS, C2PC, and GeoMedia also provide robust data processing capabilities with their mapping functions. These kinds of commercial off-the-shelf (COTS) products are the gateway to a better COP solution that can evolve into a more customized, tailored COP.

4.3 Data Collection Results

The concept of a COP is not new. The primary concern, though, is to understand the elements that will create a successful tailored COP and its goal of providing needed SA to the operators. As a result, we explored the user community to obtain the perspective of the members of that community. Even though the data collection for this effort was limited, the team had the opportunity to observe an exercise and conduct short conversations with users at Barksdale Air Force Base (AFB) and Nellis AFB. As the project continued we had less access to SMEs and could not get enough information for the user set. As a result, we relied heavily on documentation and current research in the domain, along with in-house SMEs. The following sections describe the information obtained throughout the data collection process of this effort.

4.3.1 CAOC-N, Nellis AFB

During the observations and interviews, the operators at CAOC-N provided us with feedback on their impressions of the current COP and the applications they use. The operators believe that we need to standardize the COP applications. Currently they use multiple applications, such as C2PC, for their COP instead of having one central application. The operators are currently driven to the data wall to view the COP due to reduced real estate from viewing multiple applications on their personal workstations. The fusion and correlation of data is being done in their head and not on the screen. They would also like too see more specific data, with the ability to filter data at each individual station instead of having everything on the data wall. They also suggested using smart tags that tell the operator of similar data items when a particular data item is

selected. Overall, the operators expressed a desire for a tailored COP that is simple to use that has the ability to add and hide overlays as needed.

4.3.2 JEFX 08-1, Barksdale AFB

After our visit to Nellis AFB, we had the opportunity to participate in the Joint Expeditionary Force Experiment (JEFX) 08-1 event in support of another 711 HPW/RH initiative. During the JEFX 08-1 event, the team observed operators at Barksdale AFB in Shreveport, Louisiana. As with any exercise, there were limited opportunities to interview users directly since they were focused on their tasks. However, there were still opportunities to observe them performing tasks; although no additional feedback was obtained regarding what information could be useful on a tailored COP.

4.3.3 Additional Data Collection

In addition to observing operators at Barksdale AFB and Nellis AFB, we interviewed a former JEFX 08 participant who served as the Chief of Combat Operations during the exercise. The interviewee believed that different cells should have what is important to them. The interviewee believed that a tailored COP would provide a composite picture for the large data wall. However, it should allow the individual teams and cells a more specific picture for their needs. During the interview, the interviewee suggested providing a roll-up mechanism, dependent on the conflict that would be tailored for each operator.

4.4 Elements of a tailored COP

The concept of a tailored COP is not a new idea. Trying to provide a global, seamless system where information can be accessed and used as needed, to address specific user needs, is an issue that many have been tackling for years. However, our research has strengthened the idea that there are key elements that need to be implemented in a tailored COP to maximize the operator's efficiency and productivity.

1. A tailored COP would allow operators to identify the specific information they want to monitor and to set up their own preferences so that they can access this desired data any time they log in. This would help in eliminating excess unused data from interfering with the desired over-laid data.
2. A tailored COP would provide easy to use expandable and collapsible options to allow operators to easily select the types and even specific items (such as vehicles and aircraft) they wish to view.
3. A tailored COP allows the operator to easily switch between critical displays. In an environment where a central screen is available, and several other pictures are being observed (e.g. air picture, ground picture, cyber picture, etc.) by other operators, the central screen can be switched to reveal the screen used by any of the other positions.

5.0 Conclusion

For years, organizations, including the military, have researched and implemented new technology to provide SA to individuals and large groups. As technology advanced, large screen displays emerged as a tool to display enormous amounts of data in an attempt to provide a useful common picture. Displaying large amounts of unfiltered data for individual work does not provide customized information to help individuals make decisions or efficiently complete their tasks. To facilitate increased SA and quicker decision making, we suggest implementing a tailored COP that allows individuals and teams the flexibility to see what they need when they need to see it.

For this project, the team began with a large goal of understanding what data elements were needed for tailored COP for the COD warfighters in the AOC. However, as JEFX-08 was restructured with limited focus on the COD, we modified our research to understanding the visualization and functionality requirements that are critical to establishing a successful tailored COP in any domain. We focused on determining the essential elements that any tailored COP should employ in order for individuals to successfully maintain SA and effectively complete their tasks. The information we learned and the concepts that were developed during this effort can be leveraged for any domain as a stepping stone for creating a tailored COP.

The next section provides recommended design ideas that should be included when developing a tailored COP for an operations center environment.

6.0 Recommendations

The common issues regarding the effectiveness of a COP include the following: legibility problems that occur from displaying vast amounts of data; color reproduction problems; menus and control icons obstructing the view; information overload; and lack of useful information. To help curb these issues there are four primary display elements that we recommend should be included in any tailored COP.

1. A tailored COP should maximize the map area to allow for a large viewable area to be displayed on a large screen data wall.
2. A tailored COP should be role-based in order to tailor the views and functionality based on the tasks and responsibilities of individual warfighters.
3. A tailored COP should allow sharing functionality to encourage team communication and team SA.
4. A tailored COP should allow for customization.

Based on the data collection, we have created a tailored COP concept that depicts the basic display elements discussed above. The following illustration (Figure 5) displays the Main Screen along with a description of the suggested functionality.

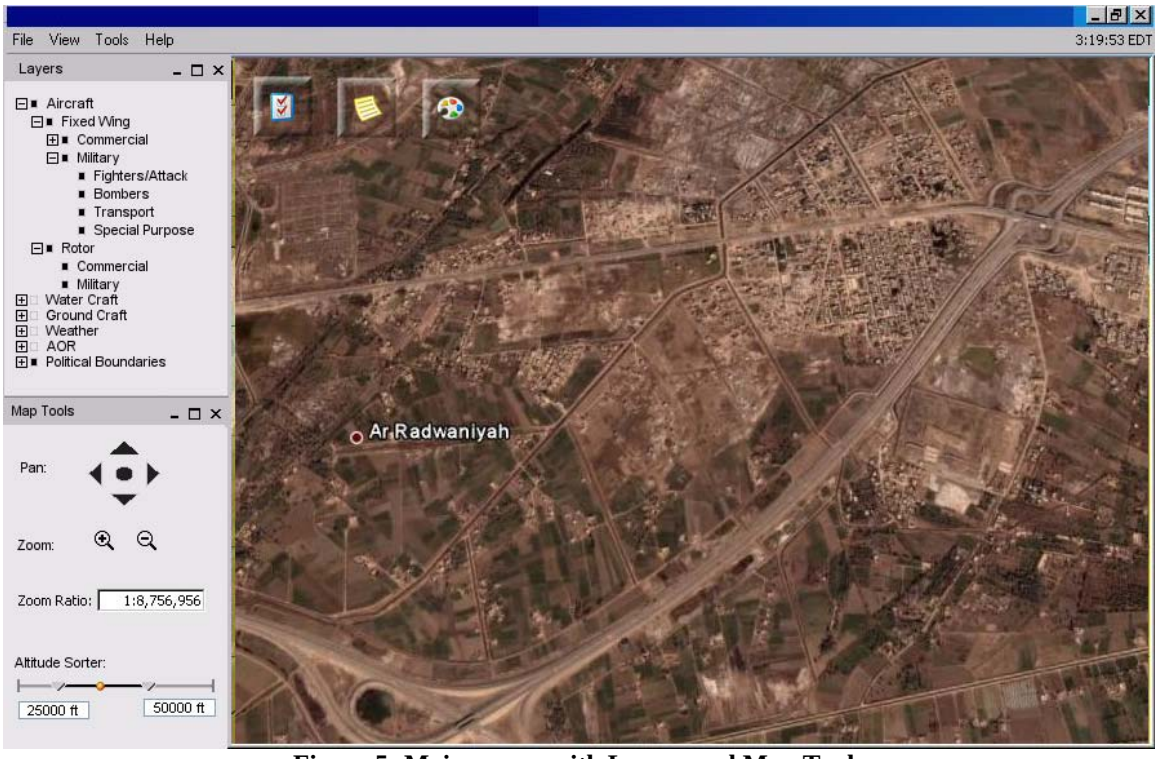

Figure 5: Main screen with Layers and Map Tools

- ***Maximize the map space on the screen*** – This is the main focus of the system and the user will need to see it as large as possible. In order to do this, we suggest that the toolbar should be reduced to quick link buttons that are customizable by the user. Users will be able to choose which ones they want to see. When the user clicks one of the quick links a

separate work area will appear. This area will be locked on whatever side of the screen the user chooses. This reduces the use of pop-up secondary screens to carry out user actions. These areas can be adjusted in size or closed at any time upon user request.

- ***Roles*** – The system will use predetermined roles that will be assigned to users based on their job expectations. This will customize the system to what each individual user typically needs to carry out a specific job function. Users may change roles at any time for any reason and they will also be able to customize their role by adding layers to their map view, adding functionalities, etc. Users will also be able to save their customized views as a new role.
- ***Sharing***
    - Role sharing – Once users save a customized role, they can make that role visible to others with the same job function.
    - Screen sharing – Users will be able to share their screen with the main COP screen or others in their group.
    - Screen merge – This is similar to a picture-in-picture function where users see their AOR merged with either the main picture or another team's picture.
- ***Custom options***
    - Layers – The user will be able to add or remove layers from their map view. This includes layers such as weather and boundaries down to individual aircraft in order to focus on a narrower picture.
    - Map Tools – Helps the user to navigate their map. This includes an altitude sorter that will allow the user to narrow down objects shown on the map to any given altitude range.
    - Drawing Tools – Allows users to add their own markings to their map picture.
    - Notes – Gives the user options to assign notes to any object on the map picture.
    - History – Allows the user to see if there is any history of any object on the map. This includes previous tracks, hostile activity, etc.
    - Custom tool tip – This allows users to customize what they see in a mouse-over tool tip for any object in the map picture. Information could include altitude, speed, heading, ID number, etc.

6.1 Conceptual Scenario

To demonstrate the tailored COP concept, we created a scenario that typifies the standard daily movement of fuel within the Iraq Theater of Operations. In this scenario, a convoy escorting three fuel trucks is traveling west from Baghdad to Fallujah. There has been sporadic reporting of unidentified vehicle and personnel traffic along the route. In the scenario there are three primary players: an operations center convoy analyst, a convoy commander (located in the field), and a director of the operations center. In the scenario each player has their own individual tailored COP that is customized for their role (See Figures 6-8).

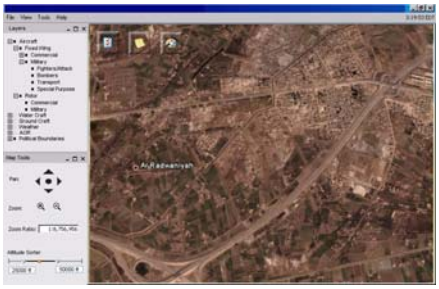

Figure 6: Operations Center COP
"This COP is viewed from the operations center convoy analyst and is on his individual workstation."

Figure 7: Convoy COP
"This COP is viewed in the field by the convoy commander."

Figure 8: Director/Main COP
"This COP is displayed on the operations center data wall, which is easily viewed by the leadership."

The tailored COP allows a communication link to be established between the convoy commander and the operations center convoy analyst. From the display, the operations center convoy analyst is informed of the impending departure of the convoy. The convoy commander has tactical control of the convoy and shares information with the operations center convoy analyst. The information shared between the operations center convoy analyst and the convoy will be shown through operations center COP. The operations center convoy analyst uses his tailored COP to review the suspicious activity movement and adds annotations with the drawing functionality. This is passed to the convoy commander (See Figure 9).

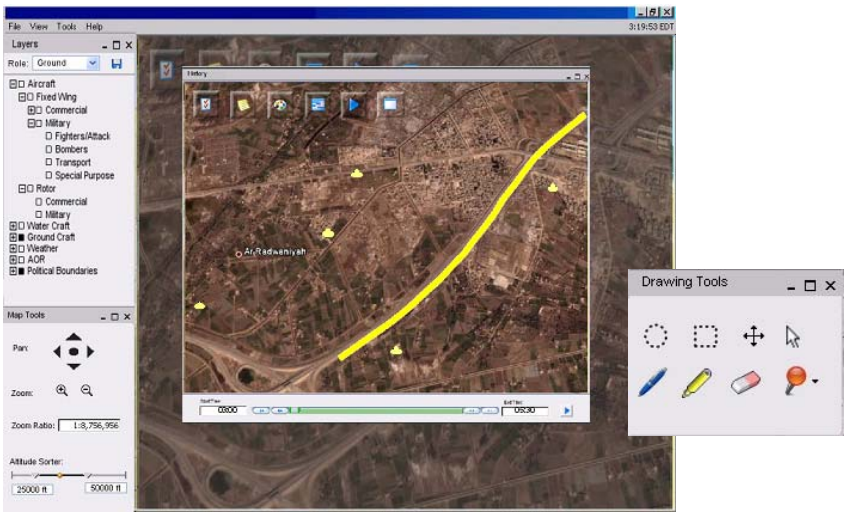

Figure 9: History Function
Reviews previous activity in an AOR and the Drawing Tools allow users to add objects to the COP.

After the convoy commander receives the update, he reports back to the operations center convoy analyst that an unidentified Iraqi male has been spotted. The convoy commander uses the Notes functionality within the tailored COP. (Figure 10 displays the message on the operations center convoy analyst's COP.)

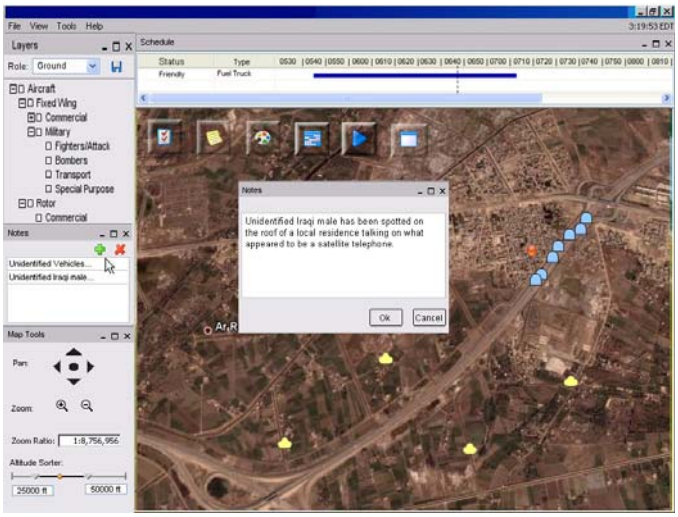

Figure 10: Notes
Keeps track of information related to the map view

The director of the operations center notices the overlays on the operations center convoy analyst's display and decides to call up his tailored COP on the main COP display in the operations center. The tailored COP concept allows operators to easily share displays with team members. Figure 11 shows how the operators can easily share their screen by selecting the options from a simple pull down menu.

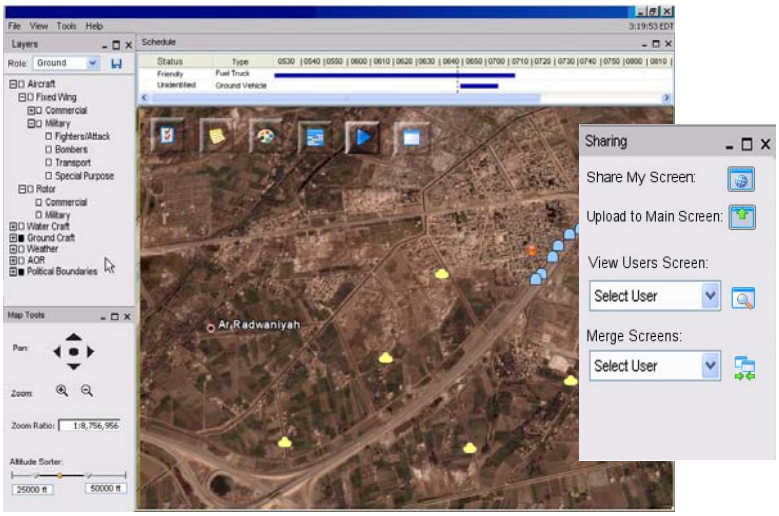

Figure 11: Sharing Display Functionality
Allows quick and easy collaboration of screens

The automated integration of data gives operators real-time updates, allowing rapid reaction to any situation. After the director of operations reviews the shared display, he asks to merge with the air picture and an overlay of any vehicles in the area that might be beneficial to the mission. He pulls up the requested airborne asset data from the Air Operations Supervisor positions and calls up all vehicles within 10 km of the site of the attack on his main tailored COP. He merges the displays with his own onto the main display. From the merged information displayed, he

directs the Air Operations Supervisor to vector the helicopters to protect the convoy. (See Figure 12)

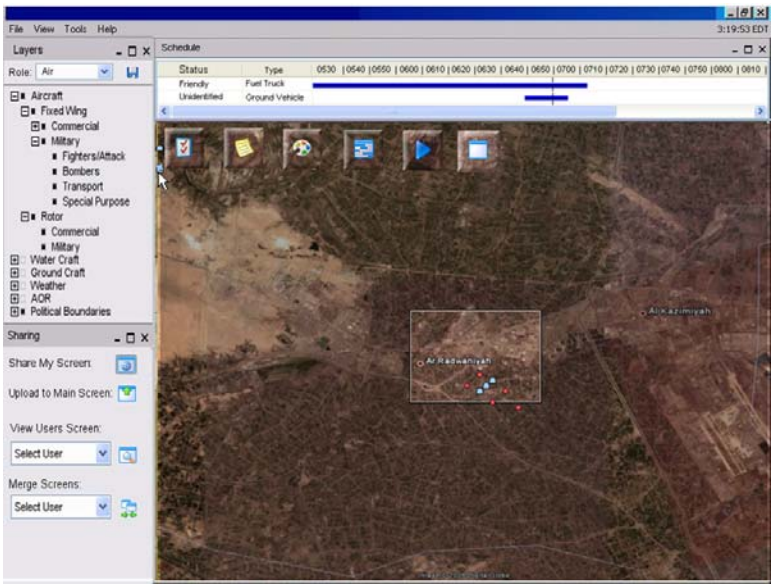

Figure 12: Merged Screens
Allows users to view other users screen while keeping track of their own

The tailored COP display also provides an estimated time of arrival in the Schedule Panel for the various assets. Once one of the operators adds information to the schedule, it can be viewed by other users of the system (See Figure 13).

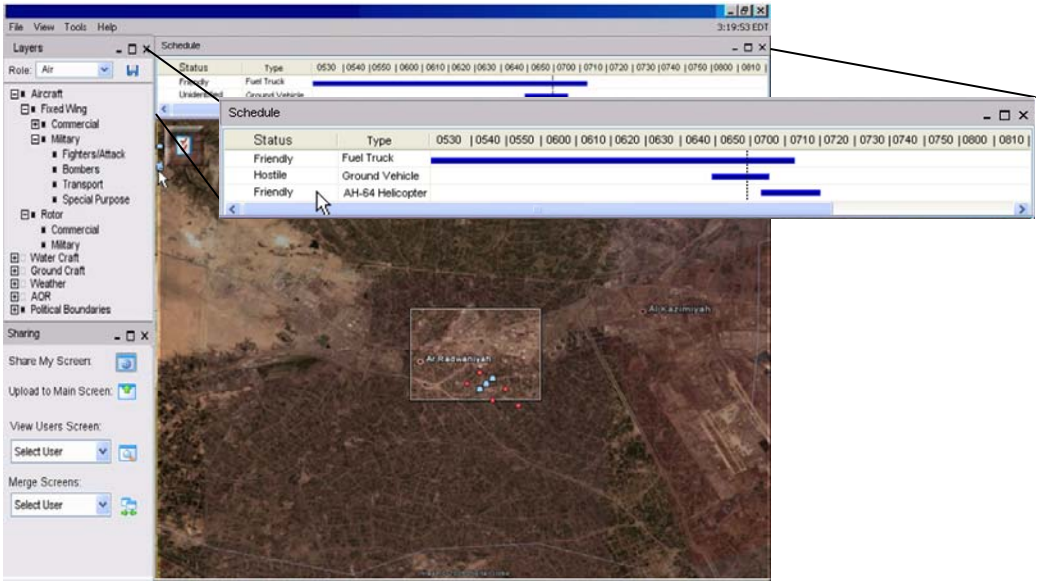

Figure 13: Schedule Panel
Shows a temporal view of the AOR in order to estimate time of arrival

With the Tailored COP, all the operators have vital SA that gives them an accurate and timely picture of what is transpiring. They have the ability to hide and show layers of interest by using the Layer Controls (See Figure 14).

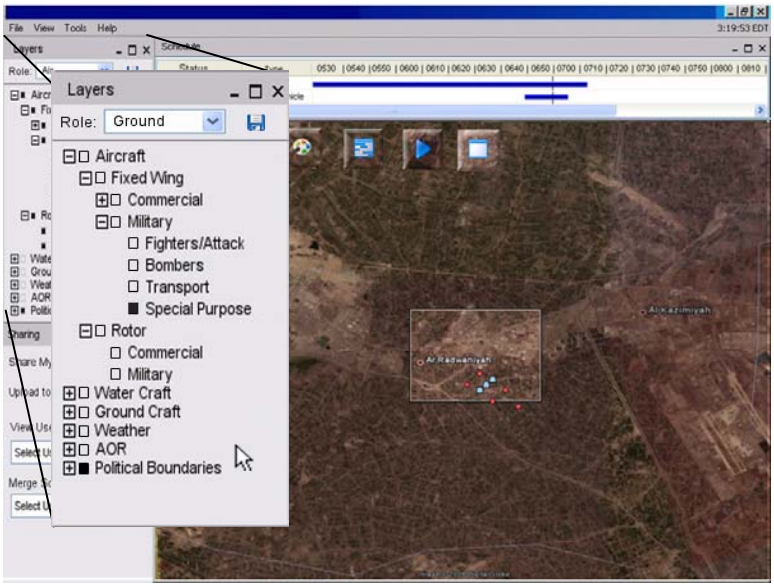

Figure 14: Layers Panel
Allows user to switch pre-defined roles or customize overlays

The flexibility of a tailored COP provides the operators with the SA required to carry out the mission. The ability to quickly communicate with team members creates a more efficient and productive environment. While the scenario focused on the players in the tactical environment and operations center, viewing and sharing information using a tailored COP provides individuals and teams with the ability to transcend all environments, including the critical air, space, and cyber domains. The concept is to provide individuals and teams with access to essential data and allow them to filter and share what they need. In addition to providing operators with functionality, it is also important for the tool to allow operators to easily complete their tasks. As a result, common human factors standards and design practices were included in the tailored COP concept to create an efficient, easy-to-use tool.

7.0 References

Artman, H. (2000). Team situation assessment and information distribution. Ergonomics, 43(8), 1111-1128.

Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. Human Factors Journal, 37(1), 32-64.

Endsley, M. R., Bolte, B, & Jones, D. G. (2003). Designing for Situation Awareness: An Approach to User-Centered Design. Boca Raton, FL: CRC; 1 ed.

Livnat, Y., Agutter, J., Moon, S., & Foresti, S. (2005). Visual Correlation for Situational Awareness. Retrieved October 9, 2008, from http://www.sci.utah.edu/publications/yarden05/VisAware.pdf

8.0 Abbreviations & Acronyms

AFB	Air Force Base
AFRL	Air Force Research Laboratory
AOC	Air and Space Operations Center
ATO	Air Tasking Order
C2PC	Command and Control for the Personal Computer
C4I	Command, Control, Communications, Computers and Intelligence
CAOC	Combined Air Operations Center
CCO	Chief of Combat Operations
CONOPS	Concept of Operations
COP	Common Operating Picture
COTS	Commercial Off –The-Shelf
DoD	Department of Defense
DTM	Dynamic Targeting Manager
GUI	Graphical User Interface
HSI	Human System Integration
ISCF	Integrated C4I System Framework
ITM	Intra-JAOC Targeting Manager
JEFX	Joint Expeditionary Experiment
RH	Human Effectiveness Directorate
SA	Situation Awareness
SME	Subject Matter Expert
STS	Special Tactics Squadron
USAFWS	United States Air Force Weapons School
WEEMC	Web Enabled Execution Management Capability
XMAN	Execution Manager